JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. VI MAY 4, 1916 No. 9

PHYSICS.—*Polarized skylight and the petrographic microscope.*[1] W. S. TANGIER SMITH. (Communicated by F. L. Ransome.)

When skylight is used with the petrographic microscope, there is often a notable loss of available light owing to its partial polarization. This polarization, like the blue color of the sky, is due to the effect of light waves on particles of matter in the atmosphere, the diameter of which is small compared with the wave-length of light, so that the light which strikes them, instead of being reflected, sets up harmonic vibrations in the particles or the surrounding ether, these vibrations in turn giving rise to light waves and resulting in what is commonly referred to as "scattered light." This scattered light, composed mainly of blue and violet rays, is polarized to a greater or less extent, since at any one point the vibrations which give rise to it are confined to a single plane transverse to the direction of transmission of the original beam of light.

The more numerous the minute particles which scatter light, and the fewer the larger reflecting particles which mask the scattered light, the bluer is the sky and the greater the polarization of its light when viewed in certain directions.

The blueness of the sky and the polarization of its light being due to the same cause, they vary for the most part together, and the polarization is therefore greatest under those circum-

[1] Read before the Cordilleran Section of the Geological Society of America. April 11, 1913.

stances which give the bluest skies. Hence it is that the polarization of the skylight and the resulting loss of light in the microscope are most evident on the brightest days, with the clearest, bluest skies, and from those parts of the sky which are the deepest blue; moreover it is especially noticeable in the more arid parts of the country and at considerable altitudes.

The polarized skylight, reflected from the mirror of the microscope, enters the lower nicol vibrating in a plane which may or may not coincide with the plane of vibration of the nicol. If the two coincide, there is of course no loss of light. When they do not, however, there is always more or less loss, sometimes amounting to one-half or more of the total illumination received by the microscope.

Any remedy for the difficulty must involve either some change in the illumination, or else a shifting of the microscope or a modification of its optical parts. Among the possible devices which would reduce or prevent the loss of light are the following:

(1) Artificial light may be used as the source of illumination, or a translucent screen may be interposed between the microscope and direct sunlight. A cloudy or foggy sky has the same effect as an interposed screen, the light from clouds being non-polarized.

(2) The microscope may be so placed that the light will come from a favorable part of the sky. As already noted, the degree of polarization of the skylight varies in different parts of the sky, being greatest in those portions from which lines to the sun and the microscope make an angle approximating 90° with each other, and decreasing rapidly on either side of this zone, more especially with approach toward the sun (fig. 1). It also decreases close to the horizon, on account of the large number of reflecting particles present in this portion of the sky. The horizon belt, however, is generally too narrow and often too low to be of much practical use; while near the sun the intensity of the light becomes too great. Thus, while the selection of favorable parts of the sky may somewhat decrease the polarization effects, it is not always a satisfactory remedy, especially when the choice is restricted to those parts visible from a single window.

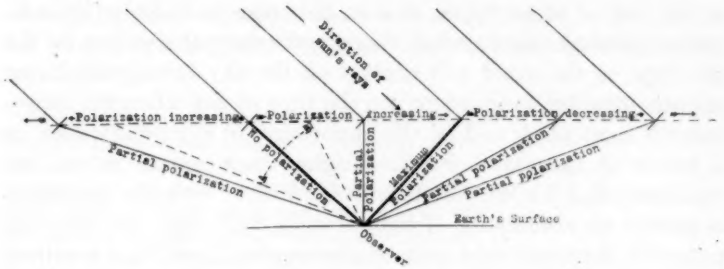

Fig. 1. Diagram to illustrate the variation in the polarization of scattered light from different parts of the sky. The short lines perpendicular to the lines representing the sun's rays are the traces of planes of vibration of harmonic motions which give rise to scattered light. *A–B* marks the approximate maximum limits of the sun's diffraction glow, the circle of intense illumination close to the sun, within which the effects of scattering are more or less masked and polarization is at a minimum.

(3) The microscope may be rotated on its base until the plane of vibration of the reflected polarized skylight coincides with that of the lower nicol of the instrument. This is a simple expedient, applicable at all times, and when the observer can move with the microscope it is entirely satisfactory. When he cannot, however, it necessitates his becoming familiar with the use of the micropscope and its accessories in varied positions, and even with such familiarity it is likely to lead to some confusion.

In this connection it may be noted that the orientation of the plane of vibration in the polarizer of the microscope may have some effect in increasing or decreasing the difficulties with polarized skylight. The plane of vibration of the lower nicol is differently oriented in different instruments, even of the same make. In the common type of the Bausch and Lomb petrographic microscope, for example, this plane of vibration is square with the instrument, in some cases running from front to rear, in others from right to left. In the "Larson Model" the plane of vibration is diagonal, sometimes in one direction, sometimes in the other. The difficulties with polarized skylight are met with

in all four of these types, and in this respect there is little to choose between them; what slight preference there may be for one type or the other will depend on the sky facing which one adopts—or often must adopt; on the time of day when the microscope is most used; and on the importance of sky polarization as a factor at noonday. F. E. Wright,[2] in a recent paper, has concluded that for Washington, D. C., where "at noon time there is always an abundance of light from a clear sky" (so that the polarized scattered light may be disregarded), and for a northern facing, and a use of the microscope at any hour of the day, "there is a slight advantage in having the plane of vibration parallel to the vertical cross-hair."

(4) A suitable compensator introduced below the polarizer of the microscope, and capable of independent rotation about the axis of the instrument, may effect practically complete correction of the polarization of the skylight and at the same time give a whiter and more favorable light. A simple type of such compensator is a thin, parallel-faced plate of some transparent, birefringent material—as quartz or muscovite—cut so as to give, theoretically, with monochromatic light of 518 $\mu\mu$ wave length (the value which yields, with the petrographic microscope, results most nearly in accord with the conditions of ordinary white light), a phasal difference of a half wave length between the entering and emerging rays of light. Practically, it is cut so as to give with ordinary light and between crossed nicols pure white of the first order as an interference color. This compensator or half-wave plate, mounted in a movable ring, should be free to rotate about the axis of the microscope through an angle of not less than 90°, and in use should be so turned that, theoretically, its planes of vibration, for light with normal incidence, bisect the angles between the planes of vibration of the reflected polarized skylight and the polarizer of the microscope (see fig. 2); practically, so as to obtain the maximum illumination. If the compensator is tested between the nicols of a microscope—the most severe test which can be applied—there is no observable

[2] Journ. Wash. Acad. Sci., 5: 641–644. 1915.

loss of light, even when the nicols are crossed. The writer has used such a compensator in his own work and finds it entirely satisfactory.

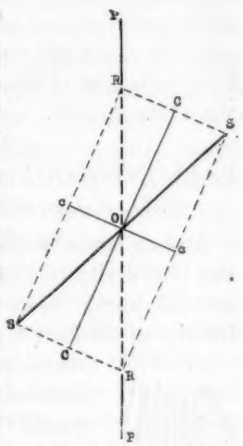

Fig. 2. Diagram to illustrate the action of the polarized-skylight compensator or half-wave plate. *S–S* is the trace of the plane of vibration of polarized skylight. *P–P* is the trace of the plane of vibration of the polarizer of the microscope. *C–C* and *c–c* are the traces of the planes of vibration in the compensator. They bisect the angles between *S–S* and *P–P*. The polarized skylight which enters the compensator, vibrating in the direction *S–S* and with amplitude *OS*, is resolved into two plane polarized rays, *C–C* and *c–c*, with amplitudes *OC* and *Oc*, respectively, and with no phasal difference. Emerging with a phasal difference of one-half wave length, these rays combine to form a single plane polarized ray, *R–R*, whose direction of vibration coincides with that of the polarizer, *P–P*, and whose amplitude, *OR*, equals that of the original ray, *OS*. Theoretically, therefore, there is no loss in the light entering the polarizer.

The compensator just described can be used, of course, only with a stationary polarizer. In order to use it with the type of microscope in which both nicols can be rotated simultaneously, it is necessary to connect the mounting of the compensator with that of the polarizer in such a way that, when the polarizer is turned through any angle, the compensator will be rotated, automatically, through half that angle, the movements of both being in the same direction. This rotation of the mounting, however, is independent of that of the compensator itself, already referred to. When both nicols are rotated simultaneously without the compensator, the intensity of the light transmitted by the polarizer may vary considerably, while with the compensator the illumination is uniform during rotation.

It may happen, during the middle of the day, that the full skylight, even from the zone of maximum polarization (which, it may be noted, is also the zone of minimum illumination), is too intense for the most satisfactory work with the petrographic microscope. At such times, when using light from this zone or

near it, the compensator may be used, not only to correct the loss of light resulting from a lack of correspondence between the planes of vibration of skylight and polarizer, but also to adjust the light to the needs of the worker, either by an incomplete correction of the light loss or, where there is already essentially complete correspondence between the vibration planes, by a reduction of the illumination through a reverse movement of the compensator.

PALEONTOLOGY.—*The uropods of* Acanthotelson stimpsoni. T. D. A. COCKERELL, University of Colorado.

Among some fossils kindly presented by Mr. L. E. Daniels to the University of Colorado Museum is a specimen of *Acanthotelson stimpsoni* Meek & Worthen in a nodule from the Carboniferous of Mazon Creek, Illinois. I have examined many examples of this species, but the present one is remarkable for the perfect preservation of the uropodal rami, permitting a more exact interpretation of their structure than was possible to Meek and Worthen, or to Packard.[1] The rami are about 9.5 mm. long, hard and perfectly spiniform, and strongly longitudinally grooved. The outer one is straight, the inner gently curved. Stiff spinelike bristles occur at intervals of somewhat less than a millimeter on both sides of the inner ramus; and also on the outer side of the outer ramus, where they are more closely set. There are in addition many very fine, soft setae fringing the rami, forming an especially long fringe on the inner side of the outer ramus. Packard's figure is, therefore, in error in showing numerous quite closely set bristles of one sort only.

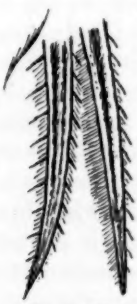

Fig. 1. Uropodal rami of *Acanthotelson stimpsoni*. About scale 4.

Acanthotelson is an animal of more than ordinary interest. It belongs to a group of Crustacea which Packard named Syncarida, peculiar freshwater Malacostraca in which there is no carapace whatever. In the Carboniferous and Permian strata of the

[1] Mem. Nat. Acad. Sci., **3**: 15th Memoir, pl. 1, fig. 1d. 1886.

northern hemisphere there is evidence of the existence of several genera. Formerly it was supposed that the group became extinct in later Paleozoic times, but in 1893 a living representative (*Anaspides* Thomson) was discovered in deep pools in the mountains of Tasmania. Still more recently two other living genera have been found: *Paranaspides* G. Smith in Tasmania and *Koonunga* Sayce in the vicinity of Melbourne, Australia. As early as the Mazon Creek Carboniferous, the appendages known as uropods had become greatly modified from a strictly primitive type. In *Palaeocaris typus* Meek & Worthen, of which an example from Mazon Creek is before me, the rami are flattened and expanded, approaching the form usual in Malacostraca, and evidently used for swimming, i.e., for propulsion in water. In *Acanthotelson*, on the other hand, the rami are of a very different nature, slender and spinelike, apparently suited for executing springing movements (comparable to those of the Collembola) in the soft sand or mud at the bottom of the water. Thus two types of modification were present; one became nearly universal, while the other, that of *Acanthotelson*, died out. *Acanthotelson* must be regarded as the type of a distinct family, Acanthotelsonidae, and the groups of Syncarida may be tabulated thus:

Rami of uropods spinelike.....ACANTHOTELSONIDAE.
(*Acanthotelson* Meek & Worthen. Mazon Creek Carboniferous.)
Rami of uropods flattened swimming organs.....1.
1. First thoracic somite quite distinct, though short....URONECTIDAE.[2]
(Permian of Europe; Carboniferous of Europe and America.)
1. First thoracic somite fused with head, the point of junction more or less indicated by a groove (living forms).....2.
2. Eyes sessile.....KOONUNGIDAE (*Koonunga*.)
2. Eyes stalked.....ANASPIDIDAE.
No dorsal hump; mandible with three-jointed uniramous palpus.
Anaspidinae (*Anaspides*).
With a dorsal hump; mandible with four-jointed biramous palpus.
Paranaspidinae (*Paranaspides*).

[2] Packard called this family Gampsonychidae, basing it on *Gampsonyx* Jordan & V. Meyer. It appears, however, that this generic name was earlier used for a genus of birds; so the next available name, *Uronectes* Bronn, has to be used. This is the Permian form; the Carboniferous one is *Palaeocaris* Meek & Worthen (*Praeanaspides* H. Woodward). *Palaeocaris typus* has a more or less distinct dorsal hump, though Packard's figure does not show it.

The fact that the three living genera are extremely distinct from one another, and are monotypic, indicates that they are ancient forms, the group having apparently lost all tendency to produce new species. The curiously restricted geological and recent distribution of the whole series shows how little we know of some types of life, which must have had a long evolutionary history now hidden from us.

I take this opportunity to note that the Arachnid family Holotergidae Petrunkevitch,[3] which occurs at Mazon Creek, must be called Curculioididae, as "Holotergidae" is not based on a generic name.

BOTANY.—*Comparative notes on the floras of New Mexico and Argentina.* PAUL C. STANDLEY, National Museum.[1]

That there exists a marked relationship between the flora of the southwestern United States and that of central and southern Argentina is a fact fairly well known to botanists. The closeness of this relationship is scarcely realized, perhaps, except by one familiar with the flora of either region when he inspects a collection of plants or goes over a list of species characteristic of the corresponding area. About three years ago Mr. Walter Fischer, at that time director of the Escuela Experimental de Agricultura at Río Negro, in the Department of Río Negro, southern Argentina, secured some three hundred numbers of plants in that vicinity. His collections were studied and named by Dr. Cristóbal M. Hicken, Professor of Botany in the University of Buenos Aires. Dr. Hicken has published recently[2] an extended report upon these specimens. The collection, although not a large one, is interesting to the student of the Argentine flora because of the considerable number of new species and of species previously unknown in Argentina which it contains.

A set of Mr. Fischer's plants was received recently by the U. S. National Museum. When the writer had occasion to inspect the specimens, he was impressed at once by the strong resem-

[3] Trans. Connecticut Acad. Arts & Sciences, **18**: 81. 1913.

[1] Published by permission of the Secretary of the Smithsonian Institution.

[2] Physis, **2**: 1–18, 101–122. 1915–16.

blance of many of the species to others of the same genera with which he is familiar in New Mexico. A comparison of the flora of this limited area with that of the Rio Grande Valley of New Mexico may be of some general interest. It is not certain that the flora of this particular region of the southwestern United States is the one with which that of the Río Negro might best be compared; but the writer, being more familiar with the vegetation of the Rio Grande Valley, is better able to use it as a basis of comparison, than some similar area in Arizona or southern California with whose flora, also, that of the Argentine region shows an equally close or possibly even closer alliance.

Río Negro is situated in southern Argentina, in about latitude 39°, upon the Río Negro, one of the larger streams of the region. The Mesilla Valley of New Mexico, with which it is proposed to compare its flora, lies along the Rio Grande in southern New Mexico, in latitude about 32° North. Judging from the data available from Mr. Fischer's notes, the two regions must bear a strong resemblance topographically: a wide river valley with large areas of heavy clay soil under irrigation, broken by stretches of sand dunes, the valley bordered by elevated sandy mesas or low hills. In the Argentine region part of the uplands appears to consist of clay soil, but in New Mexico all the mesa land is sandy, at least until the foothills of the mountains are reached. From the information at hand it is not possible to compare the composition of the corresponding zones of vegetation; consequently it seems more practicable to compare the related specific elements which constitute each flora as a whole.

It is remarkable to find that several species of plants are actually common to these two regions. These are as follows:

Agrostis verticillata Vill.
Andropogon saccharoides Swartz
Echinochloa zelayensis (H. B. K.) Schult.
Eragrostis cilianensis (All.) Link
Festuca octoflora Walt.
Paspalum distichum L.
Phragmites phragmites (L.) Karst.
Polypogon monspeliensis (L.) Desf.
Cyperus inflexus Muhl.
Eleocharis palustris (L.) R. Br.
Juncus mexicanus Willd.
Rumex persicarioides L.
Monolepis nuttalliana (Roem. & Schult.) Greene
Silene antirrhina L.
Halerpestes cymbalaria (Pursh) Greene
Daucus pusillus Michx.
Heliotropium curassavicum L.
Petunia parviflora Juss.
Solanum elaeagnifolium Cav.
Linaria canadensis (L.) Dum.

Most of these are species of wide distribution, some of them, like *Phragmites phragmites*, *Polypogon monspeliensis*, and *Eleocharis palustris*, extending to the Old World. *Polypogon monspeliensis* may even be adventive in the Western Hemisphere. Others of the list, like *Paspalum distichum*, *Juncus mexicanus*, *Heliotropium curassavicum*, and *Petunia parviflora*, have an extended range in the warmer parts of North and South America. Several of the other species, however, are not continuous in their ranges, being restricted to the temperate parts of the two American continents. Among them are *Festuca octoflora*, *Monolepis nuttalliana*, *Silene antirrhina*, *Halerpestes cymbalaria*, *Daucus pusillus*, *Solanum elaeagnifolium*, and *Linaria canadensis*. Some of these are plants which range widely in the United States, but the *Monolepis*, *Halerpestes*, *Daucus*, and *Solanum* are typically southwestern plants. *Solanum elaeagnifolium* is a characteristic plant of southern New Mexico and Arizona and of western Texas.

In addition to the species listed which are common to the two regions, certain others occurring in the Argentine area appear elsewhere in the southwestern United States. *Veronica anagallis-aquatica* L. occurs in New Mexico and Arizona, and *Lythrum hyssopifolium* L. and *Scirpus riparius* Presl in California. *Panicum urvilleanum* Kunth is known only from Arizona, California, Chile, and Argentina. *Malacothrix coulteri* Gray is common to southern California and Argentina. *Chenopodium ambrosioides* L., *Potamogeton filiformis* Pers., and *Hordeum pusillum* Nutt. are widely diffused in North America.

More interesting and suggestive is the following list of paired species. The species listed in the lefthand column are Argentine, while those in the righthand column are certain New Mexican ones which bear a close resemblance to them. A few of those cited from New Mexico do not actually occur in the Mesilla Valley but they are found at New Mexican points not far distant.

Argentine Species	New Mexican Analogues
Azolla filiculoides Lam.	*Azolla caroliniana* Willd.
Ephedra ochreata Miers	*Ephedra trifurca* Torr.

Setaria[3] *villiglumis* Hicken	*Chaetochloa composita* (H. B. K.) Scribn.
Salix chilensis Mol.	*Salix exigua* Nutt.
Parietaria debilis Forst.	*Parietaria obtusa* Rydb.
Atriplex ameghinoi Speg.	*Atriplex argentea* Nutt.
Chenopodium hircinum Schrad.	*Chenopodium incanum* (S. Wats.) Heller
Dondia divaricata (Moq.) Standley[4]	*Dondia intermedia* (S. Wats.) Heller
Clematis dioica campestris (St. Hil.) Kuntze	*Clematis ligusticifolia* Nutt.
Draba australis ameghinoi Speg.	*Draba cuneifolia* Nutt.
Radicula philippiana (Speg.) Standley[5]	*Radicula obtusa* (Nutt.) Greene
Hoffmanseggia falcaria Cav.	*Hoffmanseggia densiflora* Benth.[6]
Prosopis juliflora DC.	*Prosopis glandulosa* Torr.[7]
Strombocarpa strombulifera (Benth.) Gray	*Strombocarpa pubescens* (Benth.) Gray
Lupinus microcarpus Sims	*Lupinus pusillus* Pursh
Vicia graminea Sims	*Vicia exigua* Nutt.
Covillea cuneifolia (Cav.) Vail. *Covillea divaricata* (Cav.) Vail. *Covillea nitida* (Cav.) Vail.	*Covillea glutinosa* (Engelm.) Rydb.
Euphorbia ovalifolia argentosa Muell. Arg.	*Chamaesyce serpyllifolia* (Pers.) Small
Tithymalus portulacoides (L.) Standley[8]	*Tithymalus montanus* (Engelm.) Small
Condalia lineata Gray	*Condalia spathulata* Gray
Sida leprosa (Orb.) Schum.	*Sida hederacea* (Dougl.) Torr.
Sphaeralcea miniata (Cav.) Spach	*Sphaeralcea lobata* Wooton
Nuttallia albescens (Gill. & Arn.) Standley[9]	*Nuttallia multiflora* (Nutt.) Greene
Menodora integrifolia (Cham. & Schlecht.) Steud.	*Menodora scabra* Gray
Androsace salasii Kurtz	*Androsace occidentalis* Pursh

[3] The names *Setaria* and *Chaetochloa* apply to the same genus.

[4] *Suaeda divaricata* Moq. Chenop. Enum. 123. 1840.

[5] *Nasturtium philippianum* Speg. Bol. Agr. Buenos Aires, **1**: 200. 1901.

[6] It is doubtful whether this is distinct from *H. falcaria*. It ranges from western Texas to southern Arizona and adjacent Mexico. *H. falcaria* is found in southern South America.

[7] The relationship of this to *P. juliflora*, and the range of the latter species are very uncertain. The Argentine plant may not be *P. juliflora*, but on the other hand, *P. glandulosa* may not be sufficiently distinct from *P. juliflora*. The same species, or else two closely related ones, occurs in Argentina and New Mexico.

[8] *Euphorbia portulacoides* L. Sp. Pl. 456. 1753.

[9] *Bartonia albescens* Gill. & Arn. Edinb. Phil. Journ. **2**: 273. 1831.

Cressa australis petiolata Meissn.	*Cressa truxillensis* H. B. K.
Gilia valdiviensis Griseb.	*Gilia inconspicua* (Smith) Dougl.
Lappula redowskii (Lehm.) Greene[10]	*Lappula occidentalis* (S. Wats.) Greene
Phyla nodiflora (Michx.) Greene[11]	*Phyla incisa* Small
Verbena gracilescens Cham. & Schlecht.	*Verbena neomexicana* (Gray) Small
Lycium floribundum Dunal *Lycium pubescens* Miers	*Lycium parviflorum* Gray
Lycium wilkesii Ball	*Lycium torreyi* Gray
Nicotiana monticola Dunal	*Nicotiana trigonophylla* Dunal
Plantago patagonica Jacq.	*Plantago purshii* Roem. & Schult.
Plantago rocae Lorentz	*Plantago major* L.
Ambrosia tenuifolia Spreng.	*Ambrosia artemisiaefolia* L.
Aster squamatus (Spreng.) Hieron.	*Aster exilis* Ell.
Baccharis juncea Desf.	*Baccharis wrightii* Gray
Baccharis salicifolia Pers.	*Baccharis glutinosa* Pers.
Flaveria bidentis (L.) Kuntze	*Flaveria campestris* Johnston
Gaillardia megapotamica scabiosoides Baker	*Gaillardia pinnatifida* Torr.
Gnaphalium cheiranthifolium Lam.[12]	*Gnaphalium chilense* Spreng.
Solidago microglossa DC.	*Solidago arizonica* (Gray) Woot. & Standl.
Tessaria absinthioides DC.	*Tessaria borealis* Torr. & Gray
Thelesperma scabiosoides Less.	*Thelesperma gracile* (Torr.) Gray

In some of the cases cited the resemblance is very striking, for example, in the instance of *Ephedra, Atriplex, Draba, Lupinus, Vicia, Sida, Nuttallia, Androsace, Solidago,* and *Thelesperma.* The two Sidas belong to a small group which, in the United States, is chiefly southwestern. Other instances of representatives of genera or groups of species which with us are typical of the arid southwest, are found in species of *Ephedra, Hoffmanseggia, Strombocarpa, Covillea, Condalia, Sphaeralcea, Menodora, Cressa, Gilia, Lycium, Baccharis, Flaveria, Tessaria,* and *Thelesperma.* It is interesting to note that in Argentina the cresote bush, *Covillea,* is represented by three species, while in the southwest

[10] The determination of this species is doubtfully correct. At any rate, the plant is very close to *L. occidentalis.*

[11] The plant so determined may not really be *P. nodiflora,* but it is very like *P. incisa.*

[12] The specimens so determined are different from the plant of western South America found in herbaria under this name.

we have but a single one. *Strombocarpa strombulifera* is in many respects similar to *S. pubescens*, the well-known screw-pod mesquite or *tornillo* of the Southwest, especially in its fruits, which are almost identical. But the Argentine plant can scarcely, like its New Mexican ally, be an important source of firewood, for it is only two or three decimeters high.

Besides the instances just mentioned, certain Argentine species of *Persicaria, Gutierrezia, Grindelia, Astragalus, Glycyrrhiza, Lepidium, Pappophorum, Monnina, Phacelia, Polygala, Ximenesia, Senecio, Distichlis, Stipa, Poa, Sophia,* and *Heliotropium* bear a general resemblance to New Mexican species of the same genera. There are also represented in the collection such genera as *Myriophyllum, Tissa, Allocarya, Amsinckia, Bowlesia, Pectocarya, Buddleia,* and *Hydrocotyle,* which are not represented in the Mesilla Valley, although they occur in regions not far distant. Most of these genera, also, consist in the United States of characteristically southwestern plants. It is significant to find about Río Negro a curious xerophytic shrub belonging to the Caper Family, *Atamisquea emarginata* Miers, a species found also in Lower California but unknown in the intervening countries. Several genera which occur in the Southwest are represented in Argentina by species very unlike the North American ones. Some of these are *Lippia, Elymus, Frankenia, Verbena, Menodora, Prosopis, Atriplex, Sida, Eupatorium, Eryngium,* and *Sporobolus.* The Verbenas are specially interesting; species of this genus are very numerous in southern South America, but many of them are strikingly different from our North American ones, all of which fall into two groups, each composed of similar plants. Some of those of Argentina are shrubs, often with curious leaf form, and some of them have yellow flowers.

Of course, there are represented in this Argentine locality genera of which no species are found in the southwestern United States. Among them are *Mulinum* and *Asteriscium* (Apiaceae), *Chuquiragua* and *Cyclolepis* (Mutisiaceae), *Adesmia* (Fabaceae), *Fabiana* and *Trechonaetes* (Solanaceae), *Facelis* and *Hysterionica* (Asteraceae), *Turrigera* and *Oxystelma* (Asclepiadaceae), *Schinus*

(Anacardiaceae), *Cristaria* (Malvaceae), *Hippeastrum* (Amaryllidaceae), *Margyricarpus* (Rosaceae), *Bougainvillea* (Allioniaceae), *Arjona* (Santalaceae), and *Hypochaeris* (Cichoriaceae). Most of these have no obvious analogues in the United States, although *Oxystelma* and *Turrigera* may correspond to our *Philibertella*, and *Adesmia* in a manner take the place of *Astragalus* or perhaps *Lotus*. The family Mutisiaceae reaches its greatest development in the arid regions of western and southern South America. In North America it is represented in Mexico and the southwestern United States chiefly by the genera *Trixis* and *Perezia*.

Many of our characteristic New Mexican genera, on the other hand, are not found in Argentina. Among them may be mentioned *Tridens*, *Sitanion*, *Yucca*, *Eriogonum*, *Abronia*, *Dithyraea*, *Koeberlinia*, *Fouquieria*, *Oreocarya*, *Hymenopappus*, *Townsendia*, and *Chrysothamnus*.

From all the analogies of the two floras that have been cited it is evident that the relationship between the vegetation of southern Argentina and that of New Mexico is strongly marked. The limited size of Mr. Fischer's collection affords, of course, an insufficient basis for an extensive comparison of the vegetation of these areas, but the data afforded by other collections only accentuate the closeness of the relationship. It is evident that students of the flora of the southwestern United States would do well to devote more attention to the flora of the corresponding regions of South America. No doubt many of our United States species find their closest allies in those regions, and it may well be that in some cases identical forms common to the two areas have been described independently by botanists who relied too much upon geographic isolation in establishing their species. Probably, however, such instances are few. The botanists of California long have been aware of the relationship of their xerophytic flora to that of Chile, and have profited by this knowledge. Unfortunately the plants of southern and western South America are too poorly represented in United States herbaria at present to furnish an adequate basis for comparative studies of the flora.

Before finishing his comparison of these floral areas, the writer feels it desirable to make some mention of the adventive and naturalized plants of the Río Negro Valley represented among Mr. Fischer's collections. Of the native Argentine species two are of interest to United States botanists because they have become more or less naturalized in this country. *Poinciana gilliesii* Hook., the bird-of-paradise bush, is one of the commonest cultivated plants of the arid southwestern United States and of Mexico, and is often found as an escape from cultivation. *Amaranthus crispus* (Lesp. & Thév.) A. Br. has been collected at Albany and New York City, New York, at Wilmington, North Carolina, and at Mobile, Alabama. It was described originally from plants adventive in France, and only in very recent years has it been ascertained that its native habitat is Argentina. A list of the more noteworthy plants adventive in Argentina, as shown by the present collection, is as follows:

Agrostis alba L.
Dactylis glomerata L.
Holcus halepensis L.
Hordeum murinum L.
Phleum pratense L.
Poa annua L.
Polygonum aviculare L.
Rumex crispus L.
Atriplex rosea L.
Atriplex semibaccata R. Br.
Salsola pestifer A. Nels.
Portulaca oleracea L.
Bursa bursa-pastoris (L.) Web.
Sisymbrium altissimum L.
Medicago lupulina L.
Medicago sativa L.
Melilotus alba Desr.
Melilotus indica (L.) All.
Trifolium repens L.
Trifolium pratense L.
Erodium cicutarium (L.) L'Hér.
Convolvulus arvensis L.
Marrubium vulgare L.
Plantago lanceolata L.
Cichorium intybus L.
Sonchus asper (L.) Hill
Sonchus oleraceus L.
Taraxacum taraxacum (L.) Karst.
Xanthium spinosum L.
Anthemis cotula L.
Senecio vulgaris L.

All of the above are Old World plants which occur in New Mexico, and many of them are common in the irrigated lands of the Mesilla Valley. In addition, the following species may be mentioned which have become established in the Río Negro Valley but are not known from New Mexico, although they have become established elsewhere in the United States, most of them in the Southwest:

Lolium italicum A. Br.
Notholcus lanatus (L.) Nash
Atriplex hortensis L.
Amaranthus deflexus L.
Brassica napus L.
Brassica nigra L.
Cerastium vulgatum L.
Medicago denticulata Willd.
Medicago orbicularis All.
Conium maculatum L.
Daucus carota L.
Veronica peregrina L.[13]
Dipsacus fullonum L.
Lactuca scariola L.[14]
Centaurea melitensis L.
Cirsium lanceolatum (L.) Scop.

Several of these European plants, notably *Dipsacus fullonum*, *Centaurea melitensis*, *Hordeum murinum*, *Medicago sativa* and *M. denticulata*, *Melilotus indica*, *Marrubium vulgare*, *Erodium cicutarium*, and *Sonchus asper*, are either confined in the United States to the Southwest or else are particularly abundant there, and are known to have occurred in that region at an early date. It is probable that they reached the United States through the same agency by which they were transported to Argentina—the early Spanish settlers.

While some of the European plants cited have become widely scattered with the development of international commerce, many thrive only in temperate regions, and several of them, like the *Salsola*, *Erodium*, *Hordeum*, and *Centaurea*, seem to thrive best in arid or subarid regions. These adventive plants, combined with the more than slightly familiar aspect of the native flora, would make a botanist accustomed to our Southwestern vegetation feel very much at home when he first made the acquaintance of the Río Negro Valley of Argentina.

[13] In New Mexico we have *V. xalapensis* H.B.K. as a native species. While all botanists may not consider it specifically distinct from *V. peregrina*, it certainly is distinguished readily from the naturalized European plant.

[14] In New Mexico only *L. integrata* (Gren. & Godr.) A. Nels. is known. It is often considered a subspecies of *L. scariola*.

REFERENCES

Under this heading it is proposed to include, by author, title, and citation, references to all scientific papers published in or emanating from Washington. It is requested that authors coöperate with the editors by submitting titles promptly, following the style used below. These references are not intended to replace the more extended abstracts published elsewhere in this Journal.

PHYSICS

BUREAU OF STANDARDS. *The testing of hydrometers.* 4th ed. Circular No. 16. 1916.

BUREAU OF STANDARDS. *Invar and related nickel steels.* Circular No. 58. Pp. 68. 1916.

BUREAU OF STANDARDS. *Standard density and volumetric tables,* 5th ed. Circular No. 19. Pp. 64. 1916.

FOOTE, PAUL D., and FAIRCHILD, C. O. *Luminosity of a black body and temperature.* Bureau of Standards Sci. Paper No. 270, pp. 137–145. 1916.

CHEMISTRY

BERG, W. N. *Biochemical comparisons between mature beef and immature veal.* Journal of Agricultural Research, **4**: 667–712, figs. 1–6. January 10, 1916.

GILE, P. L., and CARRERO, J. O. *Ash composition of upland rice at various stages of growth.* Journal of Agricultural Research, **5**: 357–364. November 29, 1915.

GORE, H. C. *Studies of fruit juices.* Bulletin of the U. S. Department of Agriculture, No. 241. Pp. 1–19. June 14, 1915.

HASSELBRING, H., and HAWKINS, L. A. *Carbohydrate transformations in sweet potatoes.* Journal of Agricultural Research, **5**: 543–560. December 27, 1915.

HEADDEN, W. P. *Occurrence of manganese in wheat.* Journal of Agricultural Research, **5**: 349–356. November 22, 1915.

RUSSELL, G. A. *A study of the soft resins in sulphured and unsulphured hops in cold and in open storage.* U. S. Department of Agriculture, Bulletin No. 282. Pp. 1–19. August 11, 1915.

SHEDD, O. M. *Variations in mineral composition of sap, leaves, and stems of the wild-grape vine and sugar-maple tree.* Journal of Agricultural Research, **5**: 529–542. December 20, 1915.

THATCHER, R. W. *Enzyms of apples and their relation to the ripening process.* Journal of Agricultural Research, **5**: 103–116. October 18, 1915.

WITHERS, W. A., and CARRUTH, F. A. *Gossypol, the toxic substance in cottonseed meal.* Journal of Agricultural Research, **5**: 261–288, pls. 25–26. November 15, 1915.

SOILS

ALWAY, F. J., and BISHOP, E. S. *Nitrogen content of the humus of arid soils.* Journal of Agricultural Research, **5**: 909–916. February 14, 1916.

BROWN, P. E. *Relation between certain bacterial activities in soils and their crop-producing power.* Journal of Agricultural Research, **5**: 855–870. January 31, 1916.

BOUYOUCOS, G. J. *Effect of temperature on the movement of water vapor and capillary moisture in soils.* Journal of Agricultural Research, **5**: 141–172, figs. 1–11. October 25, 1915.

GILTNER, WARD, and LANGWORTHY, H. VIRGINIA. *Some factors influencing the longevity of soil micro-organisms subjected to desiccation, with special reference to soil solution.* Journal of Agricultural Research, **5**: 927–942. February 14, 1916.

KOCH, G. P. *Soil Protozoa.* Journal of Agricultural Research, **4**: 511–560. September, 1915.

KOCH, G. P. *Activity of soil Protozoa.* Journal of Agricultural Research, **5**: 477–488. December 13, 1915.

KOPELOFF, NICHOLAS, LINT, H. C., and COLEMAN, D. A. *Separation of soil Protozoa.* Journal of Agricultural Research. **5**: 137–140. October 18, 1915.

LECLAIR, C. A. *Influence of growth of cowpeas upon some physical, chemical, and biological properties of soil.* Journal of Agricultural Research, **5**: 439–448, figs. 1–2, pl. 42. December 6, 1915.

OSKAMP, JOSEPH. *Soil temperatures as influenced by cultural methods.* Journal of Agricultural Research, **5**: 173–180, figs. 1–4. October 25, 1915.

PLUMMER, J. K. *Petrography of some North Carolina soils and its relation to their fertilizer requirements.* Journal of Agricultural Research, **5**: 569–582, pl. 52. December 27, 1915.

BOTANY

HEDGCOCK, G. G. *Parasitism of* Comandra umbellata. Journal of Agricultural Research, **5**: 133–136. October 18, 1915.

MASON, S. C. *Botanical characters of the leaves of the date palm used in distinguishing cultivated varieties.* U. S. Department of Agriculture, Bulletin No. 223. Pp. 1–28. June 23, 1915.

PIPER, C. V., and MORSE, W. J. *The bonavist, lablab, or hyacinth bean.* U. S. Department of Agriculture, Bulletin No. 318. Pp. 1–15. November 18, 1915.

SUDWORTH, G. B. *The spruce and balsam fir trees of the Rocky Mountain region.* U. S. Department of Agriculture, Bulletin No. 327. Pp. 1–43. February 19, 1916.

WESTGATE, J. M., COE, H. S., WIANCKO, A. T., ROBBINS, F. E., HUGHES, H. D., PAMMEL, L. H., and MARTIN, J. N. *Red-clover seed production: pollination studies.* U. S. Department of Agriculture, Bulletin No. 289. Pp. 1–31. September 21, 1915.

HORTICULTURE

COVILLE, F. V. *Directions for blueberry culture, 1916.* U. S. Department of Agriculture, Bulletin No. 334. Pp. 1–16. December 28, 1916.

HUSMANN, G. C. *The raisin industry.* U. S. Department of Agriculture, Bulletin No. 349. Pp. 1–15. March 17, 1916.

MASON, S. C. *Dates of Egypt and the Sudan.* U. S. Department of Agriculture, Bulletin No. 271. Pp. 1–40. September 28, 1915.

FORESTRY

HUMPHREY, C. J., and FLEMING, RUTH M. *The toxicity to fungi of various oils and salts, particularly those used in wood preservation.* U. S. Department of Agriculture, Bulletin No. 227. Pp. 1–38. August 23, 1915.

WEIR, J. R. *Larch mistletoe: some economic considerations of its injurious effects.* U. S. Department of Agriculture, Bulletin No. 317. Pp. 1–27. January 20, 1916.

AGRONOMY

BABCOCK, F. R. *Cereal experiments at the Williston Station.* U. S. Department of Agriculture, Bulletin No. 270. Pp. 1–36. July 29, 1915.

BRIGGS, L. J., and SHANTZ, H. L. *Effect of frequent cutting on the water requirement of alfalfa and its bearing on pasturage.* Bulletin of the U. S. Department of Agriculture, No. 228. Pp. 1–6. May 22, 1915.

CATES, H. R. *Farm practice in the cultivation of corn.* U. S. Department of Agriculture, Bulletin No. 320. Pp. 1–67. January 24, 1916.

CHILCOTT, E. C., COLE, J. S., and BURR, W. W. *Barley in the Great Plains area; relation of cultural methods to production.* U. S. Department of Agriculture, Bulletin No. 222. Pp. 1–32. May 24, 1915.

CHILCOTT, E. C., COLE, J. S., and BURR, W. W. *Oats in the Great Plains area; relation of cultural methods to production.* U. S. Departmentof Agriculture, Bulletin No. 218. Pp. 1–42. May 28, 1915.

CHILCOTT, E. C., COLE, J. S., and BURR, W. W. *Corn in the Great Plains area; relation of cultural methods to production.* U. S. Department of Agriculture, Bulletin No. 219. Pp. 1–31. June 2, 1915.

CHILCOTT, E. C., COLE, J. S., and BURR, W. W. *Crop production in the Great Plains area; relation of cultural methods to yields.* U. S. Department of Agriculture, Bulletin No. 268. Pp. 1–28. July 20, 1915.

CHILCOTT, E. F., GRIGGS, W. D., and BURMEISTER, C. A. *Corn, milo, and kafir in the southern Great Plains area; relation of cultural methods to production.* Bulletin of the U. S. Department of Agriculture, No. 242. Pp.1–20. June 19, 1915.

DILLMAN, A. C. *Breeding millet and sorgo for drought adaptation.* U. S. Department of Agriculture, Bulletin No. 291. Pp. 1–19. January 25, 1916.

GRACE, O. J. *The effect of different times of plowing small-grain stubble in eastern Colorado.* U. S. Department of Agriculture, Bulletin No. 253. Pp. 1–15. June 29, 1915.

MCLACHLAN, ARGYLE. *Community production of Durango cotton in the Imperial Valley.* U. S. Department of Agriculture, Bulletin No. 324. Pp. 1–16. December 22, 1915.

MEADE, R. M. *Single-stalk cotton culture at San Antonio.* U. S. Department of Agriculture, Bulletin No. 279. Pp. 1–20. August 24, 1915.

SALMON, CECIL. *Cereal investigations on the Belle Fourche Experiment Farm.* U. S. Department of Agriculture, Bulletin No. 297. Pp. 1–43. October 28, 1915.

SCOFIELD, C. S., KEARNEY, T. H., BRAND, C. J., COOK, O. F., and SWINGLE, W. T. *Community production of Egyptian cotton in the United States.* U. S. Department of Agriculture, Bulletin No. 332. Pp. 1–30. January 13, 1916.

SAUNDERS, D. A., and CARDON, P. V. *Custom ginning as a factor in cotton-seed deterioration.* U. S. Department of Agriculture, Bulletin No. 288. Pp. 1–8. September 7, 1915.

SHAW, H. B. *Sugar beets: Preventable losses in culture.* U. S. Department of Agriculture, Bulletin No. 238. Pp. 1–21. July 14, 1915.

STANTON, T. R. *Cereal experiments in Maryland and Virginia.* U. S. Department of Agriculture, Bulletin No. 336. Pp. 1–52. February 10, 1916.

SURFACE, F. M., and PEARL, RAYMOND. *A method of correcting for soil heterogeneity in variety tests.* Journal of Agricultural Research, **5**: 1039–1050, fig. 1, February 28, 1916.

VINALL, H. N., and MCKEE, ROLAND. *Moisture content and shrinkage of forage; and the relation of these factors to the accuracy of experimental data.* U. S. Department of Agriculture, Bulletin No. 353. Pp. 1–37. March 16, 1916.

ZOOK, L. L. *Tests of corn varieties on the Great Plains.* U. S. Department of Agriculture, Bulletin No. 307. Pp. 1–20. December 14, 1915.

BACTERIOLOGY

COOLEDGE, L. H. *Agglutination test as a means of studying the presence of* Bacillus abortus *in milk.* Journal of Agricultural Research, **5**: 871–876. February 7, 1916.

PHYTOPATHOLOGY

ALLARD, H. A. *Distribution of the virus of the mosaic disease in capsules, filaments, anthers, and pistils of affected tobacco plants.* Journal of Agricultural Research, **5**: 251–256, pl. 23. November 8, 1915.

BROOKS, CHARLES, and FISHER, D. F. *Brown-rot of prunes and cherries in the Pacific Northwest.* U. S. Department of Agriculture, Bulletin No. 368. Pp. 1–10. March 6, 1916.

BROWN, NELLIE A. *A bacterial disease of lettuce.* Journal of Agricultural Research, **4**: 475–478. August, 1915.

BRYAN, MARY K. *A nasturtium wilt caused by* Bacterium solanacearum. Journal of Agricultural Research, **4**: 451–358, figs. 1–3, pls. 63–66. August, 1915.

CARPENTER, C. W. *Some potato tuber-rots caused by species of Fusarium.* Journal of Agricultural Research, **5**: 183–210, pls. A–B, pls. 14–19. November 1, 1915.

COBB, N. A. Tylenchus similis, *the cause of a root disease of sugar cane and banana.* Journal of Agricultural Research, **4**: 561–568, figs. 1–2. September, 1915.

COONS, G. H. *Factors involved in the growth and the pycnidium formation of* Plenodomus fuscomaculans. Journal of Agricultural Research, **5**: 713-770. January 17, 1916.

EDSON, H. A. *Histological relations of sugar-beet seedlings and* Phoma Betae. Journal of Agricultural Research, **5**: 55–58, pls. 1–2. October 4, 1915.

HARTER, L. L. *Sweet-potato scurf.* Journal of Agricultural Research, **5**: 787–792, pls. 57–58. January 24, 1916.

HEDGCOCK, G. G., and LONG, W. H. *A disease of pines caused by* Cronartium pyriforme. Bulletin of the U. S. Department of Agriculture, No. 247. Pp. 1–20. July 20, 1915.

JACKSON, H. S. *An Asiatic species of Gymnosporangium established in Oregon.* Journal of Agricultural Research, **5**: 1003–1010, pls. 78–79. February 28, 1916.

LONG, W. H. *Two new hosts for* Péridermium pyriforme. Journal of Agricultural Research, **5**: 289–290, pl. 27. November 15, 1915.

LONG, W. H. *A honeycomb heart-rot of oaks caused by* Stereum subpileatum. Journal of Agricultural Research, **5**: 421–428, pl. 41. December 6, 1915.

MELHUS, I. E. *Hibernation of* Phytophthora infestans *of the Irish Potato.* Journal of Agricultural Research, **5**: 71–102, figs, 1–3, pls. 4–8. October 11, 1915.

MELHUS, I. E. *Perennial mycelium in species of Peronosporaceae related to* Phytophthora infestans. Journal of Agricultural Research, **5**: 59–70, fig. 1, pl. 3. October 11, 1915.

POOL, VENUS W., and MCKAY, M. B. *Relation of stomatal movement to infection by* Cercospora beticola. Journal of Agricultural Research, **5**: 1011–1038, figs. 1–6, pls. 80–81. February 28, 1916.

RAND, F. V. *Dissemination of bacterial wilt of cucurbits.* Journal of Agricultural Research, **5**: 257–260, pl. 24. November 8, 1915.

ROSENBAUM, J. *Pathogenicity and identity of* Sclerotinia libertiana *and* Sclerotinia smilacina *on ginseng.* Journal of Agricultural Research, **5**: 291–298, fig. 1, pls. 28–29. November 15, 1915.

ROSENBAUM, J., and ZINNSMEISTER, C. L. Alternaria panax, *the cause of a root-rot of ginseng.* Journal of Agricultural Research, **5**: 181–182, pls. 12–13. October 25, 1915.

SMITH, ERWIN F., and BRYAN, MARY K. *Angular leaf-spot of cucumbers.* Journal of Agricultural Research, **5**: 465–476, pls. 43–49. December 13, 1915.

STAKMAN, E. C., and JENSEN, LOUISE. *Infection experiments with timothy rust.* Journal of Agricultural Research, **5**: 211–216. November 1, 1915.

TAUBENHAUS, J. J. *Soilstain, or scurf, of the sweet potato.* Journal of Agricultural Research, **5**: 995–1002, pls. 76–77. February 21, 1916.

VALLEAU, W. D. *Varietal resistance of plums to brown-rot.* Journal of Agricultural Research, **5**: 365–396, pls. 37–39. November 29, 1915.

WEIR, J. R., and HUBERT, E. E. *A serious disease in forest nurseries caused by* Peridermium filamentosum. Journal of Agricultural Research, **5**: 781–786. January 24, 1916.

WOLF, F. A. *Further studies on peanut leafspot.* Journal of Agricultural Research, **5**: 891–902. February 7, 1916.

PLANT PHYSIOLOGY

BARTRAM, H. E. *Effect of natural low temperature on certain fungi and bacteria.* Journal of Agricultural Research, **5**: 651–656. January 3, 1916.

BRIGGS, L. J., and SHANTZ, H. L. *Influence of hybridization and cross-pollination on water requirement of plants.* Journal of Agricultural Research, **4**: 391–402, fig. 1, pl. 58. August, 1915.

BRIGGS, L. J., and SHANTZ, H. L. *An automatic transpiration scale of large capacity for use with freely exposed plants.* Journal of Agricultural Research, **5**: 117–132, figs. 1–18, pls. 9–11. October 18, 1915.

BRIGGS, L. J., and SHANTZ, H. L. *Hourly transpiration rate on clear days as determined by cyclic environmental factors.* Journal of Agricultural Research, **5**: 583–650, figs. 1–22, pls. 53–55. January 3, 1916.

BUCKNER, G. D. *Translocation of mineral constituents of seeds and tubers of certain plants during growth.* Journal of Agricultural Research, **5**: 449–458. December 13, 1915.

COOK, F. C. *Boron: Its absorption and distribution in plants and its effect on growth.* Journal of Agricultural Research, **5**: 877–890. February 7, 1916.

FRED, E. B. *Relation of green manures to the failure of certain seedlings.* Journal of Agricultural Research, **5**: 1161–1176, pls. 83–84. March 20, 1916.

HARRIS, F. S. *Effect of alkali salts in soils on the germination and growth of crops.* Journal of Agricultural Research, **5**: 1–54, figs. 1–48. October 4, 1915.

HART, E. B., and TOTTINGHAM, W. E. *Relation of sulphur compounds to plant nutrition.* Journal of Agricultural Research, **5**: 233–250, pls. 20–22. November 8, 1915.

HASSELBRING, H., and HAWKINS, L. A. *Respiration experiments with sweet potatoes.* Journal of Agricultural Research, **5**: 509–518. December 20, 1915.

MCGEORGE, W. T. *Fate and effect of arsenic applied as a spray for weeds.* Journal of Agricultural Research, **5**: 459–464. December 13, 1915.

PITZ, WALTER. *Effect of elemental sulphur and of calcium sulphate on certain of the higher and lower forms of plant life.* Journal of Agricultural Research. **5**: 771–780, pl. 56. January 17, 1916.

EVOLUTION

BELLING, JOHN. *Inheritance of length of pod in certain crosses.* Journal of Agricultural Research, **5**: 405–420, pl. 40. December 6, 1915.

RIETZ, H. L., and ROBERTS, ELMER. *Degree of resemblance of parents and offspring with respect to birth as twins for registered Shropshire sheep.* Journal of Agricultural Research, **4**: 479–510. September, 1915.

SIEVERS, A. F. *Some effects of selection on the production of alkaloids in belladonna.* U. S. Department of Agriculture, Bulletin No. 306. Pp. 1–20. October 15, 1915.

WENTWORTH, E. N., and AUBEL, C. E. *Inheritance of fertility in swine.* Journal of Agricultural Research, **5**: 1145–1160, figs. 1–4. March 20, 1916.

ANIMAL HUSBANDRY

CURTIS, MAYNIE R. *Frequency of occurrence of tumors in the domestic fowl.* Journal of Agricultural Research, **5**: 397–404. November 29, 1915.

PEARL, RAYMOND. *Measurement of the winter cycle in the egg production of domestic fowl.* Journal of Agricultural Research, **5**: 429–438. December 6, 1915.

STEENBOCK, H. *Diuresis and milk flow.* Journal of Agricultural Research, **5**: 561–568. December 27, 1915.

WOODWARD, T. E., TURNER, W. F., and GRIFFITHS, DAVID. *Prickly-pears as a feed for dairy cows.* Journal of Agricultural Research, **4**: 405–450, fig. 1, pl. F, pls. 61–62. August, 1915.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 304th meeting assembled in the lecture room of the Cosmos Club on February 9, 1916, and immediately adjourned out of respect to the memory of Dr. C. WILLARD HAYES, past President.

The 305th meeting was held in the lecture room of the Cosmos Club on February 23, 1916.

REGULAR PROGRAM

CHARLES BUTTS: *Faults of unusual character in central Pennsylvania* (Illustrated). In the vicinity of Henrietta, in the southeast corner of the Hollidaysburg quadrangle, Pennsylvania, a wedge-shaped block 8 to 10 miles long and 2 miles wide at base is thrust up between younger rocks. The maximum throw is at the point of the wedge at the north end where the Waynesboro formation, of Middle Cambrian age, is in contact with dolomite of Beekmantown age. The relations resulting from the converging faults are abnormal for the Appalachian valley. The fault block is overthrust along the west fault and relatively downthrown along the east fault. The west fault is the major one and seems to extend northward for a long distance. It, or one in the same line of disturbance, is revealed in a cut of the Pennsylvania Railroad at Birmingham, Pennsylvania, where the fault plane dips eastward about 15°.

Several possible explanations were given for the abnormal relations along the fault on the west side of the wedge: First, that it is a normal fault downthrown on the east; second, that it was formed long subsequent to the west fault and after deep erosion, the movement being along the bedding plane of the base of the Beekmantown limestone; and third, that it took place along a second original fissure east of that along which the main overthrust occurred, at a time when the arch was completely overturned in such a way as to bring the second fissure into line with the direction of the maximum pressure of the overthrusting force.

LAURENCE LAFORGE: *Résumé of the geology of southeastern New England in the light of field work since 1908* (Illustrated). No abstract.

ALFRED H. BROOKS: *The physiographic provinces of Alaska* (Illustrated).

Five principal physiographic provinces, each divisible into subprovinces, are recognizable in Alaska. These are (1) Pacific Mountain system, (2) Central Plateau region, (3) Rocky Mountain system, (4) Arctic Mountain system, and (5) Arctic Slope region.

The Pacific Mountain system is made up of a number of parallel ranges forming a rugged highland of crescentic outline sweeping around the Gulf of Alaska. Its central part is upwards of two hundred miles in width, but the system narrows to the southeast and to the southwest. It is continued to the southeast by the Coast Range of British Columbia and to the southwest by the rugged Aleutian Islands. Several subprovinces of lesser relief are included within the Pacific Mountain system. In most places the inland slope of this system falls off abruptly to the Central Plateau region, though the line of demarcation between the two provinces is not everywhere well defined.

The Central Plateau region is characterized by flat-topped interstream areas separated by broad valleys and lowlands and broken by minor ranges and peaks that rise above the general level. The plateau feature is best developed in the upper Yukon basin, for it loses its definition on approaching Bering Sea. Here the characteristic topography consists of low rounded highlands rising island-like from broad lowlands.

The Rocky Mountain system maintains its northwesterly trend through western Canada to within about 400 miles of the Arctic Ocean and then bends to the west and enters Alaska as a single range (Ogilvie Mountains). Crossing the boundary just south of the 66th parallel it loses its definition and soon merges with the flat summits of the Central Plateau region. The Crazy and White Mountains of the Yukon-Tanana region that stand above the plateau level lie in the continuation of the Rocky Mountain axis.

A new name, Arctic Mountain system, is proposed for the east and west trending mountain system of northern Alaska formerly regarded as part of the Rocky Mountain system. Recent investigations by Canadian and American geologists have shown that this is a distinct system from the Rocky Mountains, although they are connected by the flat-topped Richardson Mountains forming the Mackenzie-Porcupine divide. The Arctic Mountain system stretches westward from the International Boundary to the Arctic Ocean north of Kotzebue Sound. It is not everywhere sharply differentiated from the plateau region to the south, for in many places the dissected plateau remnants merge with the foothills of the ranges. In its western part the northern limit of the lowland of the Kobuk Valley affords a definite line of demarcation. On the north the mountains, so far as known, everywhere fall off abruptly to the Arctic Slope. This scarp affords a definite boundary line between the two provinces. The system is made up throughout its extent of two or more parallel ranges and includes some broad lowlands. These lowlands are specially striking topographic features in

the western half of the chain. The Arctic Mountain system is continued east of the boundary by some mountains of lesser altitude. These end in a scarp at the Mackenzie delta, east of which they have not been recognized.

The Arctic Slope region has two subdivisions, the Anaktuvuk Plateau and the Coastal Plain. The first forms a piedmont plateau sloping northward from the base of the range. Along the Colville River it has a width of about 50 miles, but it narrows to the east. At the boundary it appears to be entirely absent, for here only a narrow coastal plain intervenes between the mountains and the sea. The westward extension of Anaktuvuk Plateau is unexplored. On the north the plateau is bounded by a scarp which separates it from the Coastal Plain. This plain varies from a width of less than 10 miles at the bounary to over 150 south of Point Barrow.

All of the features described, except those of the Arctic Slope region, form a part of the North American cordillera. Tectonically, however, the Arctic Mountain system is a discordant element in this cordillera. Its structures parallel the Arctic Ocean, and its folding was probably caused by movements from the Polar Sea. Tectonically and possibly physiographically it is to be correlated with the Werojanski Range and its northeastward extension of Siberia.

The 306th meeting was held in the lecture room of the Cosmos Club on March 8, 1916.

REGULAR PROGRAM

C. F. BOWEN: *Review of the stratigraphy and structure of the Hanna Basin, Wyoming.*

In the early Territorial surveys under King, Hayden, and Powell the 20,000 feet of coal-bearing rocks overlying the uppermost marine sediments of the Hanna Basin—the Lewis shale—were grouped in a single formation, for which the name Laramie was adopted.

In 1907, A. C. Veatch (U. S. Geol. Survey Bull. 316, p. 246. 1907.) subdivided this group into two formations which he designated as "Upper and Lower Laramie." Correlating a conglomerate at the base of the "Upper Laramie" on the west side of the basin with a conglomerate that marked a pronounced unconformity on the east side of the basin, he announced that the "Upper and Lower Laramie" were separated by an unconformity that involved the removal of 20,000 feet of strata. Veatch's upper division became the type of the "Upper Laramie" formation, and the flora which it yielded was adopted as a standard for comparison in other fields.

Recent detailed work over three quadrangles in the Hanna Basin has demonstrated that the unconformity which Veatch assigned to the base of the "Upper Laramie" is really near the middle of that formation or 6,500 feet above the position to which he assigned it. The "Upper Laramie" of Veatch is thus divisible into two formations sepa-

rated by a marked unconformity which permits the upper part of that formation to transgress across all of the older formations exposed.

There are no structural evidences of the supposed unconformity between the "Upper and Lower Laramie" as defined by Veatch. No angular or erosional discordance or apparent evidence of overlap between the two formations was noted. Furthermore both seem to have been equally affected by diastrophic disturbances. The only apparent evidence in support of an unconformity at this horizon is the presence of a conglomeratic zone, the base of which has been taken as the boundary between the two formations. Recent petrographic studies seem, however, to indicate that this conglomerate was not derived from the surrounding mountains but was obtained from a more remote source—apparently that which furnished the sediments of the "Lower Laramie." The conglomerate seems to have been deposited before the orogenic disturbances which gave rise to the present mountain ranges surrounding the Hanna Basin and without any great physical break between it and the underlying formation.

These observations seem to indicate that the great post-Cretaceous orogenic disturbance and resultant unconformity occurred about the middle of the so-called "Upper Laramie" epoch rather than preceding it; that is, it is pre-Wasatch instead of pre-Fort Union.

CARROLL H. WEGEMANN: *The discovery of Wasatch fossils in so-called Fort Union beds of Powder River Basin, Wyoming, and its bearing on the stratigraphy of the region.*

The rocks overlying the Fox Hills in the region southeast of the Bighorn Mountains of Wyoming have been divided by most writers into two formations,—the Lance or Triceratops beds below and the Fort Union above. The Fort Union is separable, on lithologic grounds, into two divisions; the lower carries abundant fossil leaves and consists of shale and fine-grained bluish-white sandstone, together with numerous thin beds of highly ferruginous sandstone; the upper is composed of gray shale and rather coarse-grained yellow and buff sandstone (the color of the whole formation being predominantly yellow), ferruginous beds are lacking, and fossil leaves are not abundant. During the past season specimens were obtained, by R. W. Howell and the writer, of teeth of *Coryphodon molestus* from beds near the top of the upper disvision of the Fort Union as exposed in the Pumpkin Buttes, and from beds near the middle of the formation. *Coryphodon molestus* is known only from the Wasatch, and the finding of its remains in the upper division of the Fort Union appears sufficient evidence for the correlation of that division with the true Wasatch. Former collections, near the base of the upper division of the so-called Fort Union, of small mammal teeth resembling species collected from the Torrejon of New Mexico and the Silberling Quarry of Montana are not considered by Dr. J. W. Gidley as necessarily establishing the correlation of the beds in which they were found with the Fort Union, since recent discoveries in the Clark Fork and Sand Coulee beds of Wyoming and in the Ignacio beds of Colorado have proved

that these primitive mammals are not confined to the Fort Union but are present also in the Wasatch beds.

The fresh-water formations above the marine Fox Hills appear, therefore, to belong to three formations: The Lance at the base, bearing Triceratops; the Fort Union in the middle, bearing abundant leaves; and the Wasatch at the top, containing remains of Coryphodon. The Kingsbury conglomerate in the vicinity of Buffalo is probably basal Wasatch, and the great erosional unconformity on which it rests represents the one which is present at many localities between the Fort Union and Wasatch formations.

C. J. HARES: *Stratigraphic relations of some of the Cretaceous and Tertiary formations of the Hanna and Powder River basins with those of the Wind River Basin.*

Mountains did not exist or were very small between Hanna, Wind River, Big Horn, and Powder River basins until the lower group of the Upper Laramie of Hanna Basin, the Great Pine Ridge beds of Powder River Basin, and the beds mapped as Fort Union in Wind River Basin were deposited. Only in the Bighorn Basin has an unconformity been demonstrated below a formation correlated with these beds. The position of the so-called Fort Union beds, only 250 feet above the Lewis Shale at Alkali Butte, is now believed to be due to extraordinary thinning of the Lance formation. These widely separated so-called Fort Union beds contain the same cherty conglomerate, but contain, so far as satisfactorily shown, no pebbles of Upper Cretaceous age, except possibly west of Rawlins and at Alkali Butte. Should the pebbles at these localities prove to be Mowry shale, then it is still necessary to prove that the containing beds are pre-Wind River in age. These formations contain no dinosaur bones, but many Fort Union leaves. Succeeding their deposition orogenic movements were pronounced between the present intermontane basins; in the Granite Mountains relative uplift amounting to nearly 20,000 feet took place, but in the middle of the basins the algebraic sum of the movements was nearly zero.

Succeeding these greatly deformed so-called Fort Union beds occurs the only profound, angular, and overlapping unconformity in the Cretaceous-Eocene series of Wyoming. This occurs at the base of the Wind River formation and is believed to be obvious at all places except in the middle of the basins of deposition. The Wind River formation rests on upturned Cambrian to Fort Union strata, and the relief of this old surface even in short distances is certainly 1000 feet and may have amounted to 5000 feet. The Wind River formation contains fragments of all underlying formations including Madison limestone pebbles with Niobrara fossils and ferruginous material containing Fort Union leaves, all derived from the adjacent mountains. Strata below the unconformity contain no recognizable local material. Thin sections of Mesaverde, Lower Laramie, lower group of the Upper Laramie, Lance, and so-called Fort Union show no marked differences. The Wind River formation contains much arkosic material and granite

bowlders up to 5 by 10 by 20 feet, which are now found 8 miles or more from the nearest granite outcrop. They were probably transported by sapping and water. The type Wind River is like the "Wasatch" at Whiskey Peak, which can be traced southward to the U. P. Railway, and is of the same age as the beds above the angular unconformity in the Hanna Basin. It is like the Wasatch of Bighorn Basin and the Coryphodon bearing beds of Powder River Basin, which include the Kingsbury conglomerate resting on upturned formations including Madison limestone and the Great Pine Ridge beds. The unconformity below the Kingsbury is of more than local importance and corresponds to the pronounced angular unconformity in the other basins. The formations above this unconformity in each basin except the Hanna Basin contain a Coryphodon fauna that varies somewhat from basin to basin, more because of incompleteness of collections than of difference in age.

Two alternatives appear to be possible; first, the terms Fort Union, Wind River, and Wasatch may apply to the same group of strata or, second, the type Fort Union of North Dakota may include at the top beds of Wind River age and should therefore be separable into Fort Union below and Wind River above. The first alternative appears the more probable.

The Wind River is unconformably overlain by the White River formation, which is highly arkosic, volcanic, clayey, and conglomeratic, and contains pebbles of lava and andesitic porphyry, the latter derived from the intrusives in the Rattlesnake Mountains. The porphyry pebbles are not found in the Wind River, and hence are post-Wind River and pre-White River in age. The North Park formation of Hanna Basin and possibly the Browns Park formation of Colorado, which are of like composition and position, are of the same age.

CARROLL H. WEGEMANN, *Secretary.*

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 552d regular meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club, Saturday, March 11, 1916, at 8:00 p.m.; called to order by President HAY, with 28 persons present.

On recommendation of the Council the following persons were elected to active membership: Dr. MOLYNEUX L. TURNER, R. T. JACKSON, H. L. VIERECK.

Under the heading Brief Notes and Exhibition of Specimens, Dr. SHUFELDT exhibited lantern slide views of some of the aquatic and terrestial vertebrates of the District of Columbia and vicinity.

Under the same heading Mr. WM. PALMER made remarks on, and exhibited, the bones of a hitherto unknown cetacean lately collected by him at Chesapeake Beach, Maryland.

The first paper of the regular program was by M. W. LYON, JR.: *Hemolysis and complement fixation.* Dr. Lyon outlined the steps in

the discovery of hemolysis by normal and immune serums from the early observation following transfusion by Landois in 1875, through Pfeiffer's phenomenon of bacteriolysis in 1899, Bordet's discovery of of complement in 1899, and Bordet and Gengou's discovery of complement fixation in 1901 to the practical application of the latter phenomenon as utilized by Wassermann in 1905 and by later workers in the diagnosis of syphilis, glanders, Malta fever, dourine, tuberculosis, infectious abortion, etc. The graphic conceptions of amboceptor, complement, antigen, and fixation as understood by Ehrlich, and as understood by Bordet, were illustrated by movable models. The action of hemolytic amboceptors and complement on blood cells of the ox and of the sheep was demonstrated by test tube mixtures, and some positive and negative results in complement fixation were exhibited.

The last paper of the regular program was by D. L. VAN DINE: *A study of malarial mosquitoes in their relation to agriculture.* Mr. Van Dine said that the Bureau of Entomology is making a study of the relation of malaria to agriculture and of the malaria-bearing mosquitoes, on a plantation in the lower Mississippi valley where typical conditions as regards malaria and plantation operations occur. The object is to devise measures for prevention of malaria which will apply practically to farming conditions. Lines of work include determination of the manner in which malaria operates in reducing farm profits, of the relative efficiency of *Anopheles* to act as transmitting agent and their distribution, of behavior of each species under known conditions of environment, and consideration of preventative measures which involve control of mosquito hosts. Solution centers around prevention of malaria among tenants, since it has been shown that the direct loss to planters occurs through lost time and reduced efficiency in labor. Detailed study was made of tenants, their relation to the plantation, their habits, and the prevalence of malaria among them, the conclusion being that it will be more practical to control the mosquito than the human host.

One measure of prevention consists in the favorable location of tenants' houses, requiring information on habits of flight, food, and breeding of the mosquitoes. Where drainage is impracticable, surface water must be rendered unsuitable for *Anopheles* development. Food requirements and natural checks to larval development are being studied, the Bureau of Fisheries coöperating in the study of the relation of fish to mosquito development.

Anopheles quadrimaculatus, A. punctipennis, and *A. crucians* were the species studied. *A. quadrimaculatus* is the common house-frequenting species of that region, *A. crucians* occurs in very limited numbers, and *A. punctipennis* is more restricted in its house habits but is common in nature. The work thus far has dealt almost entirely with *A. quadrimaculatus,* but following the demonstration of tertian and estivo-autumnal malaria in *A. punctipennis* by King in coöperation with Bass it will be expanded to include this species. The study includes the habits of mosquitoes under low temperature conditions; also the

resistance of malaria organisms to low temperatures in the body of the mosquito host.

Mr. Van Dine's paper was illustrated with lantern slide views of the various conditions on the plantation. Messrs. WILLIAM PALMER, DOOLITTLE, and KNAB took part in the discussion.

The 553d regular meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club, Saturday, March 25, 1916, at 8 p.m.; called to order by President W. P. HAY, with 40 persons present.

The President called attention to the recent death of Henry Talbott, a member of the Society.

Under the heading Brief Notes and Exhibition of Specimens, General WHEELER showed lantern slide views of the country along the Mexican border of the United States. Mr. A. A. DOOLITTLE exhibited a specimen of *Amblystoma punctatum* from the District of Columbia. Dr. O. P. HAY exhibited the mutilated braincase of an elk which had caused much difficulty in identification; he showed also a remarkably well preserved skull of an extinct horse. President HAY exhibited a number of lantern slides of biological interest, chiefly of aquatic animals in the vicinity of Beaufort, North Carolina. Medical Inspector AMES asked if any member present had positive knowledge as to the ability of camels to swim; this question was discussed by several members. He also inquired as to the possible existence of a South American animal with dorsally placed mammae.

The regular program was as follows:

W. P. HAY: *Notes on the growth of the loggerhead turtle* (Illustrated by lantern slides and chart). Mr. Hay gave an account of two young loggerhead turtles now under observation at the U. S. Fisheries Biological Station at Beaufort, North Carolina. They are the survivors of a lot of 77 hatched September 9 to 11, 1912, from eggs obtained from a nest on Bogue Bank about six weeks earlier. When first hatched the average size and weight of the young were: Total length 77.3 mm.; length of carapace, 46.2 mm.; weight, 20.1 gram. At the age of three years the survivors measure 493 and 515 mm. in total length and 343.75 and 365 mm. in length of carapace, and weigh 6690 and 7967 grams, respectively. The increase in size and weight has been steady and the measurements, which have been taken twice a year, can be plotted as points on a curve. This curve continued indicates that the maximum size of this species, about 1000 mm. in length of carapace, may possibly be obtained in the tenth or eleventh year and that sexual maturity is probably reached in the sixth or seventh year. This is considerably more rapid growth than has usually been attributed to animals of this kind.

The paper was discussed by Dr. R. W. SHUFELDT, Dr. O. P. HAY, Medical Inspector AMES, and Mr. DOOLITTLE.

R. W. SHUFELDT: *The restoration of the dinosaur, Podokesaurus holyokensis.* Dr. Shufeldt gave an historical account of a discussion

upon the restoration of the dinosaur *Podokesaurus holyokensis* of Talbot, which took place in the autumn of 1915. This discussion was carried on in correspondence and participated in by Dr. RICHARD S. LULL, DR. MIGNON TALBOT, DR. GERHARD HEILMANN, and the speaker. Lantern slide illustration and blackboard demonstration were employed to point out what were held to be inconsistencies in the restoration of this animal, as figured in Dr. Lull's *Triassic Life of the Connecticut Valley* (fig. 31). Lull and Talbot contend that the pubic element in the matrix of *Podokesaurus holyokensis* occupies the position in relation to the other bones of the skeleton that obtained in life. Shufeldt and Heilman controvert this decision by pointing out that all the bones in the slab containing the remains of this dinosaur are far removed from their normal articulations and that if the pubic element were articulated as Lull has figured it, it would have come, in life, forcibly in contact, anteriorly, with the sternal ribs and been a constant menace to the abdominal viscera in various movements of the animal.

R. E. COKER: *A biological and fish cultural experiment station* (Illustrated by lantern slides). Mr. Coker said that since biologists, at least, are generally familiar with the functions of the Fairport Biological Station in the propagation and study of the fresh-water mussels, particular attention would be given to the purposes of that station in experimental work relating to the rearing of fishes. As in horticulture the problems of the nurseryman and those of the fruit grower are distinct, so in fish-culture and in fish-culture experimental work there is the phase of the hatchery, with its product of fry and fingerling, and that of the fish farm where it is intended to rear fish to adult size in commerical quantities. The Fairport station is concerned with problems of rearing rather than of hatching. The grower of fish has problems similar to those of the stock farmer or the poultry raiser, while in addition he must take thought of conditions affecting the respiration of fish. He cannot always regulate the numbers of fishes in his ponds by direct means, but may have to accomplish this end by proper association of species. It may even be necessary to group together species which are to an extent "incompatible." The problem of the fish pond has its mechanical, physical, chemical, and zoological aspects; more especially, however, it is a problem of appropriate vegetation, promotion of food supply, and proper association of species of fish.

Following the adjournment of the Society several members examined a microscopic preparation of a living embryo of *Filaria bancrofti* obtained by Dr. M. W. LYON from a former inhabitant of British Guiana, for several years resident in the District of Columbia.

M. W. LYON, JR., *Recording Secretary.*

THE CELEBRATION OF THE ONE HUNDREDTH ANNIVERSARY OF THE ORGANIZATION OF THE U. S. COAST AND GEODETIC SURVEY

In 1816 the U. S. Coast Survey was organized under Mr. Ferdinand Rudolph Hassler as Superintendent and field work was begun. This event was fittingly celebrated in Washington on the 5th and 6th of April last by meetings to which the public was invited in the auditorium of the New National Museum. At these meetings papers were presented by representative men in the fields of Science, Engineering, Commerce, the Federal Government, and Military Affairs. The celebration closed with a banquet at the New Willard hotel on the evening of the sixth, at which the President of the United States was the principal speaker. The present Superintendent of the Coast and Geodetic Survey, Mr. E. Lester Jones, presided at the banquet and at the three public sessions at the Museum. Abstracts of the addresses delivered at the Museum and at the banquet are given below.

AFTERNOON OF APRIL 5TH

Dr. HUGH M. SMITH, Commissioner of Fisheries: *The Bureau of Fisheries and its relation to the United States Coast and Geodetic Survey.* Dr. Smith said that early in the history of the Bureau of Fisheries there began close coöperative relations with the Coast and Geodetic Survey. The former has always depended upon the latter for its basic triangulation whenever a biological survey of any kind has been undertaken in a region in which the Coast and Geodetic Survey has operated, which of course means anywhere on the coast of the United States. On the other hand, the hydrographic and topographic results of this biological work have always been made available to the Survey. On both the Atlantic and the Pacific coasts a considerable part of the offshore soundings found on the charts was made by the steamers *Fish Hawk* and *Albatross* in pursuance of their fishery investigations, and some of the inshore data of certain of the earlier charts came from reconnaissances by the *Albatross*. While much of the latter has been superseded by more accurate work, as the Coast Survey was able to extend its operations, it served a good purpose for some years.

Dr. L. A. BAUER, Director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington: *The work done by the United States Coast and Geodetic Survey in the field of terrestrial magnetism.* From the earliest days of the Coast Survey magnetic observations have been considered a legitimate and useful part of its work, but it was not

until 1899 that an increased appropriation made it possible to undertake a systematic magnetic survey of the United States. The first chart issued by the Survey (in 1855) showing the lines of equal magnetic declination was based on only about 150 values distributed very irregularly near the seacoast. At the close of 1915 the number of stations was about 5000, distributed over the whole country with a fair degree of uniformity, and observations had been made at about 500 stations in our outlying possessions. Meridian lines for the use of surveyors had been established at many county seats, magnetic data at sea had been obtained by vessels of the Survey, and magnetic observatories (5 since 1903) had been maintained for recording continuously the countless fluctuations of the earth's magnetism. An extensive compilation of the available data relating to the change of the compass direction with lapse of time, combined with the systematic reoccupation of old magnetic stations, has made it possible for the Survey to furnish promptly information of great value in the settlement of disputed land boundaries, established by compass as much as 100 or 150 years ago. It may be said, without fear of contradiction, that the contributions of the Coast and Geodetic Survey to the advancement of our knowledge in terrestrial magnetism have not been excelled by those of any other national organization.

Dr. S. W. STRATTON, Director of the United States Bureau of Standards: *The Bureau of Standards and its relation to the United States Coast and Geodetic Survey.* The speaker sketched the history of the various standards which have been used in this country and paid a high tribute to Mr. Hassler for creating the division of weights and measures of the Survey. This division became in 1904 the present Bureau of Standards, a separate organization. He spoke of the close coöperation which has always obtained between the Bureau of Standards and the Coast and Geodetic Survey.

Rear Admiral J. E. PILLSBURY, United States Navy (Retired): *Ocean currents and deep sea explorations of the United States Coast and Geodetic Survey.* After mentioning the early voyagers who came in contact with and noticed the Gulf Stream, the speaker gave a brief description of the first American investigation, that of Benjamin Franklin. It was not until 1845, under the administration of A. D. Bache, that the Coast Survey began a systematic study of the Gulf Stream. From that year until 1853 many vessels were engaged in the work under the most comprehensive orders. In 1867 Prof. Henry Mitchell of the Coast Survey began an investigation of the Gulf Stream by a new method. He sounded between Key West and Havana and observed currents to 600 fathoms by means of cans floating or suspended from a floating can. In 1883 the first attempt was made to investigate the actual flow of the Gulf Stream by a vessel at anchor, when the Schooner *Drift,* under Lieutenant Fremont, anchored with wire rope and observed the currents between Jupiter Inlet, Florida, and Memory Rock, Bahama. The results were of so great value that the Superintendent decided to continue the work. The *Blake,* under Lieutenant Pillsbury,

was the vessel chosen, and during the following five years she was engaged in Gulf Stream work each winter season and several summers. As to results, it was found that the velocity of the Gulf Stream varied daily, according to the moon's transit, and monthly, following its declination, and that these variations could be predicted with fair accuracy. A calculation as to its volume, deduced from many hundreds of observations in the narrowest part of the Straits of Florida, was 90,000,000,000 tons per hour.

Dr. GEORGE OTIS SMITH, Director of the United States Geological Survey: *The United States Geological Survey and its relation to the United States Coast and Geodetic Survey.* The Coast and Geodetic Survey and the Geological Survey have much in common. The field of endeavor for each is nation-wide; they are scientific in spirit and civil in organization; both are primarily field services; and the product of most of the work of each reaches the public in the form of maps. With full opportunity to overlap their fields of operation, to duplicate work, and thus to waste public money, there has been economical coördination rather than wasteful competition. In these days when, as American citizens, we have such deep concern in the question of public regulation of private business, it may be opportune for some of us as public officials to pause and consider the question of regulation of public business. In making the informal comparison of the actual and ideal in the administration of the scientific bureaus of the Government, the speaker had ever in mind the existence of a real basis for optimism in the splendid record of the Coast and Geodetic Survey and the Geological Survey in absolutely coördinating their endeavors in the public service.

EVENING OF APRIL 5TH

Hon. J. HAMPTON MOORE, Member of the United States House of Representatives: *The United States Coast and Geodetic Survey's part in the development of commerce.* Mr. Moore spoke of the relation of the Coast and Geodetic Survey to Commerce and, after paying high tribute to the perseverance and loyalty of the men of the Service, said that commerce itself did not fully appreciate the importance of the work. He spoke in particular of the needs of extending the surveys along the Atlantic coast. Along the coasts of Florida there are 172,000 square miles of water area which should be charted accurately for the use of ships engaged in commerce and in national defense. He also called attention to the changes made by the waves and currents on the North Carolina, Virginia, and New Jersey coasts. He stated that inlets close and open according to the whims of nature and that it is an interesting historical fact that no living man is now able to locate the inlet through which passed the expedition of Sir Walter Raleigh which made the first English settlement on Roanoke Island in 1584. That the vessels of Amadis and Barlow entered Croatan Sound is well established, but the channel through which they came has long since disappeared.

Brigadier General W. M. BLACK, Chief of Engineers, United States Army: *The United States Corps of Engineers and its relation to the United States Coast and Geodetic Survey.* The speaker said that the association in work of the Corps of Engineers and the United States Coast and Geodetic Survey began with the organization of the Survey. In 1802 the Corps of Engineers was organized as a separate body, of which the U. S. Military Academy formed a part. The first Superintendent of the Coast and Geodetic Survey, Ferdinand R. Hassler, was appointed from the Corps of Instructors of the Academy, having served there as Acting Professor of Mathematics from 1807 until 1810. From 1843 through a period of many years officers of both the Army and Navy served by detail with the Coast Survey Bureau. When a harbor is to be improved the first recourse of the Army Engineer is to the charts of the Coast and Geodetic Survey. The triangulation points established by the Survey are used, when available, as a basis for the work of the Engineers. Free interchange of information is made between the two organizations, and the work of one supplements that of the other. In yet another way the work of the Coast and Geodetic Survey is useful to and is utilized by the Corps of Engineers, namely, in the preparation of projects for national defense; for this purpose the charts of the Survey are at once available. The work of the Survey and that of the U. S. Engineers touch at many points, but their respective spheres of duty are well defined and separate. The great work done by the Coast and Geodetic Survey in its hundred years of existence and the traditions of faithful labor well performed will always be an inspiration for further effort.

Hon. GEORGE R. PUTNAM, Commissioner of Lighthouses: *The Lighthouse Service and its relation to the United States Coast and Geodetic Survey.* The speaker said that all progressive countries recognize their obligations to survey, light, and mark their coasts, and that when a country builds a lighthouse or publishes a chart, it aids the whole family of nations. An accurate survey of the coast is a necessary preliminary to the location of aids to navigation; without an accurate chart an aid may be so stationed as to lead a vessel on to some hidden danger. The two bureaus under discussion have the important common object of protecting the mariner and keeping him out of danger. One gives him the chart showing where the course is safe; the other gives him aids to guide him over the course. The Coast and Geodetic Survey has made special surveys for choosing sites of lighthouses, and accurately determines their positions. The Lighthouse Service marks new dangers located by surveys, and moves aids as new surveys show the need. Much work is required in keeping charts corrected for changes in aids, and in this work there must be close coöperation. On a single chart, that of New York Harbor, there are shown 299 aids. As both nature and the works of man are ever changing the coast line, channels, and harbors, and as the needs of commerce are continually varying, both charts and beacons must ever be corrected and modified; therefore, the coöperation in these two important works must always be continued.

Mr. GEORGE WASHINGTON LITTLEHALES, Hydrographic Engineer, United States Hydrographic Office: *Hydrography and charts with special reference to the work of the United States Coast and Geodetic Survey.* The speaker pointed out that a century ago the United States instituted a survey of its coasts and authorized as an aid large drafts from the Army in earlier years and yet larger ones from the Navy as long as they could be spared from the battle fleet. It is the province of marine hydrography to chart the features of the submerged border to the land, thereby indicating the hidden dangers to be avoided and the safe channels, for the guidance of shipping to and from our ports, not only at home but also in the distant countries under our jurisdiction. It must be with no small degree of pride that men should feel that their calling has made the coast of the United States its best known geographical feature, a calling so enriched with the heroisms of the sea and so unexcelled for the aggregate of its influence in promoting the security of shipping and in safeguarding the lives of seamen.

AFTERNOON OF APRIL 6TH

Prof. WILLIAM HENRY BURGER, College of Engineering, Northwestern University: *The contribution of the United States Coast and and Geodetic Survey to geodesy.* Previous to 1843 the geodetic function was little in evidence in the work of the Coast Survey; but upon the reorganization in that year, the broad and far-reaching plans advocated by Superintendent Hassler were adopted and the corner stone was laid for that fine system of geodetic operations which the Survey has at present. A further impetus was given when the geodetic connection between the Atlantic and Pacific coasts of the United States was authorized, the result of which was the great arc of triangulation along the 39th parallel. Another arc of note is the Eastern Oblique Arc from the Bay of Fundy to New Orleans, which binds together the surveys of the harbors on the Atlantic coast. Many other arcs have been measured by the Survey, until now the length of the combined arcs is more than three-sevenths of the circuit of the globe. The precise leveling work by the Survey stands without a rival in the world, as judged by the very magnitude of its operations, by the instruments employed, and in the speed and cost. The formation of the great telegraphic longitude net of the Coast and Geodetic Survey is a geodetic feat worthy of special notice. The problem of determining the shape and size of the earth may be said to be the climax in geodetic work, from a scientific point of view, and in this the Coast and Geodetic Survey has contributed much to the field of geodesy.

Rear Admiral RICHARD WAINWRIGHT, United States Navy (Retired): *The Civil War record of the United States Coast and Geodetic Survey and what the Survey is doing towards preparedness.* Mentioning his acquaintance with the Coast and Geodetic Survey for over 60 years as warrant for attempting to give the record of the field force of the

Survey during the Civil War, the speaker referred to the officers of the Survey as early volunteers of their services to the country and to their assistance, which was eagerly sought by generals in the field and admirals afloat. They gave valuable military service during the Civil War, and afterward returned to their regular duties without any of the rewards of rank or pay or pension for themselves or families so freely distributed at this time for military services. In a future war the field force of the Coast and Geodetic Survey will be needed as it was during the Civil War. The Army and Navy are both very short of officers and there is little likelihood of its being otherwise for many years. A trained topographer will always be of value on the staff of a general. In modern war with long-range guns the general must visualize his work by close reference to the map, and a topographer from the Coast Survey would find little training necessary to keep the new features and movements of the troops plotted ready for the commanding general. In the Navy a skilled hydrographer would prove a most valuable addition to the staff of an admiral. His power of quickly locating his position on a chart would be of assistance in bombardment, blockading, mining, and countermining. On the practical side, the work of the Survey has been done well and with economy. The Coast and Geodetic Survey charts stand at the head of all others for accuracy of execution and in general usefulness.

Dr. Otto Hilgard Tittmann, President of the National Geographic Society. *The international work of the United States Coast and Geodetic Survey.* Speaking of the international work of the Coast and Geodetic Survey done in direct coöperation with other countries, Mr. Tittmann said that it may justly give satisfaction to the members of the Survey that the results of its work are nearly all international in their scope. The hydrographic and tidal surveys are obviously for the benefit of all mankind, because they safeguard the commercial intercourse of nations. Its geodetic work contributes to the knowledge of the Earth's dimensions and constitution. The world's knowledge of terrestrial magnetism would be incomplete without the record of the observation of magnetic phenomena as they occur in the vast territory inhabited by us, and so with those relating to tides. Thus, in the prosecution of its tasks the Survey adds to our knowledge of the planet which we inhabit and thereby furthers the ultimate aim of all civilization, the intellectual development of mankind.

After reviewing briefly the delimitation by the Survey of the Alaska boundary, extending over a length of about 1800 miles, Dr. Tittmann described the part taken by the Survey in the delimitation and remonumenting of our Canadian and Mexican boundaries, an undertaking which he considered the most striking of the Survey's international accomplishments. He then spoke of the relation of the Survey to the International Geodetic Association and described the Survey's share in the scientific work leading to the establishment of the International Bureau of Weights and Measures.

Dr. CHARLES LANE POOR, Professor of Celestial Mechanics, Columbia University: *Oceanic tides, with special reference to the work of the United States Coast and Geodetic Survey.* The mathematical theory of the tides first assumes a solid Earth surrounded by a shallow, frictionless ocean, in which the moon would cause waves to travel around the earth from east to west. While this is apparently a simple problem, conditions which actually exist, with the ocean varying in depth and broken up by continents, present a most complex one. Yet scientists for years considered the tides as an ideally simple wave, modified and broken up by the continental barriers and the varying depths of the ocean. This world wave theory, based on a study of European tides, which are exceptionally simple, became the basis of all tidal work and theories. Later the tides of the Pacific were studied; and although they differed greatly from those of Europe, the discrepancy was explained away as a modification of the theory, due to some local condition.

The Coast and Geodetic Survey has for a century collected and discussed an enormous amount of tidal data in the Pacific and Atlantic Oceans. These data revealed so many departures of the observed tides from those predicated upon the world wave theory, that the accepted general tidal wave would have to be so radically modified, in order to represent the observed phenomena, as to lose all semblance to a single uniform progressive wave. Gradually a feeling was evolved that the tides were not a world phenomenon, but were strictly local in character; that the tides of the Atlantic were due to oscillations in the waters of the Atlantic, independent of what might be happening in the Pacific. This idea has been developed by the Coast and Geodetic Survey into a thoroughly consistent theory, and stands out as the great scientific contribution of the survey to the theories of oceanic tides.

Dr. DOUGLAS WILSON JOHNSON, Associate Professor of Physiography, Columbia University: *The contribution of the United States Coast and Geodetic Survey to physical geography.* Every division of physical geography has been enriched by the contributions of the Coast and Geodetic Survey during the century of its existence. We are indebted to this Bureau for notable additions to our knowledge of the size and form of the Earth and associated phenomena as developed in its work in latitude, variation of latitude, longitude, azimuth, triangulation, gravity, and terrestrial magnetism. To the physical hydrography of the ocean it has supplied data for detailed study of material and relief of the bottom. Its studies of the Gulf Stream and other currents have produced notable results. The Survey's treatment of the subject of the tides and tidal currents has been exhaustive, culminating in a monumental expansion of the equilibrium theory of tides. Its charts record the changes in coastal topography and exemplify the laws which govern the action of wave and current. To the physical geography of the atmosphere this organization has contributed a study of the winds and related phenomena.

EVENING OF APRIL 6TH

Dr. PAUL RITTER, Minister of Switzerland: *Hassler, the organizer of the United States Coast and Geodetic Survey.*

The Minister of Switzerland said that he owed his presence at the banquet to the circumstance that the first Superintendent of the Coast and Geodetic Survey was the Swiss engineer, Ferdinand R. Hassler. He sketched the life and career of Mr. Hassler in Switzerland, his native land, and also in the United States, to which country he migrated in order to satisfy his desire for wider fields of activity. In 1807 Hassler submitted a plan to Congress for the survey of the coasts, which was adopted. In 1816 he was appointed Superintendent of the Coast Survey, and in that year field work was begun.

Hon. JOSEPHUS DANIELS, Secretary of the Navy: *The coöperation of the United States Coast and Geodetic Survey with the Navy.*

The Secretary of the Navy spoke of the coöperation between the Coast and Geodetic Survey and the Navy and called particular attention to the fact that for a number of years naval officers were detailed for duty in the Survey, where they had charge of the vessels engaged upon the hydrographic work. When the Spanish war began, the naval officers returned to the regular naval duties on the fleets. Since that time all of the work of the Survey has been done by civilians.

Hon. WILLIAM C. REDFIELD, Secretary of Commerce: *The scope and needs of the United States Coast and Geodetic Survey.*

The address of the Secretary of Commerce was a tribute to the members of the Survey and a plea for support for the Survey by the public and by Congress, in order that it might be able to render still greater usefulness to the nation in the safeguarding of ships and lives on the oceans and in assisting in the development of the country.

Dr. T. C. MENDENHALL, former Superintendent of the Coast and Geodetic Survey: *The superintendents of the United States Coast and Geodetic Survey.*

Dr. Mendenhall took as his theme the salient features of the careers of the various superintendents of the Survey, starting with Hassler. He sketched the development and progress of the Survey during its one hundred years of existence and expressed the hope that its work during the next century might compare in character with that of the first one.

THE PRESIDENT OF THE UNITED STATES: *The scientific spirit of the United States Coast and Geodetic Survey.*

During the course of his address, in referring to the Coast and Geodetic Survey, the PRESIDENT said:

"This is one of the few branches of the public service in which the motives of those who are engaged cannot be questioned. There is something very intensely appealing to the imagination in the intellectual ardor which men bestow upon scientific inquiry. No social advantage can be gained by it. No pecuniary advantage can be gained by it. In most cases no personal distinction can be gained by it. It is

one of the few pursuits in life which gets all its momentum from pure intellectual ardor, from a love of finding out what the truth is, regardless of all human circumstances, as if the mind wished to put itself into intimate communication with the mind of the Almighty itself. There is something in scientific inquiry which is eminently spiritual in its nature. It is the spirit of man wishing to square himself accurately with his environment not only, but also wishing to get at the intimate interpretations of his relationship to his environment; and when you think of what the Geodetic Survey has been attempting to do—to make a sort of profile picture, a sort of profile sketch, of the life of a nation, so far as that life is physically sustained,—you can see that what we have been doing has been, so to say, to test and outline the whole underpinning of a great civilization; and just as the finding of all the outlines of the earth's surface that underlie the sea is a process of making the pathways for the great intercourse which has bound nations together, so the work that we do upon the continent itself is the work of interpreting and outlining the conditions which surround the life of a great nation."

E. LESTER JONES,
Superintendent, U. S. Coast and Geodetic Survey.

V
e
N
A
Y
1
e
XU